18

Lighting and Signaling Circuit Operation and Diagnosis

OBJECTIVES: After studying Chapter 18, the reader should be able to:

1. Prepare for ASE Electrical/Electronic Systems (A6) certification test content area "E" (Lighting System Diagnosis and Repair)
2. Determine which replacement bulb to use on a given vehicle.
3. Describe how turn signals work.
4. Use a bulb chart.
5. Discuss troubleshooting procedures for lighting and signaling circuits.

The lighting and signaling circuits represent two of the most frequently serviced automotive electrical areas.

LIGHTING

Exterior lighting is controlled by the headlight switch, which is connected directly to the battery on most vehicles. Therefore, if lights are left on, it can drain the battery. Most headlight switches contain a built-in circuit breaker. If excessive current flows through the headlight circuit, the circuit breaker will momentarily open the circuit, then close it again. The result is headlights that flicker on and off rapidly.

NOTE: This flickering on and off is misunderstood by many drivers and technicians. Because the flickering is rapid, many people believe that the problem is caused by a loose headlight or by a defective voltage regulator.

This feature allows the headlights to function, as a safety measure, in spite of current overload. The headlight switch controls the following lights on most vehicles:

1. Headlights
2. Taillights
3. Side marker lights
4. Front parking lights
5. Dash lights
6. Interior (dome) light(s)

NOTE: Because these lights can easily drain the battery if accidentally left on, many newer vehicles control these lights through the vehicle's computer. The computer keeps track of the time the lights are on and can turn them off if the time is excessive. The computer can control either the power side or the ground side of the circuit.

BULB NUMBERS

The number used on automotive bulbs is called the bulb **trade number,** as recorded with the American National Standards Institute (ANSI), and the number is the same regardless of the manufacturer. Amber-color bulbs that use natural amber glass are indicated

with an "NA" for *natural amber* at the end of the number (for example, #1157NA). A less expensive amber bulb that uses painted glass is labeled "A" for *amber* (for example, #1157A). See Figure 18–1.

Figure 18–1 Bulbs that have the same trade number have the same operating voltage and wattage. The NA means that the bulb uses a natural amber glass ampoule for use with clear turn signal lenses.

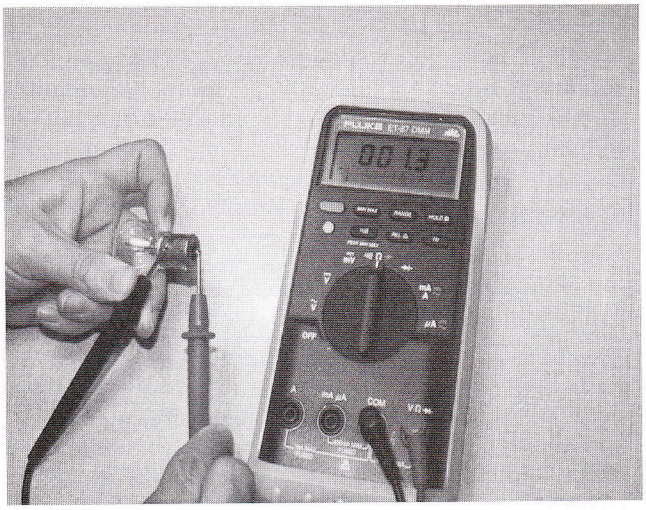


Figure 18–2 This single-filament bulb is being tested with a digital multimeter set to read resistance in ohms. The reading of 1.3 ohms is the resistance of the bulb when cold. As soon as current flows through the filament, the resistance increases about 10 times. It is the initial surge of current flowing through the filament when the bulb is cool that causes many bulbs to fail in cold weather as a result of the reduced resistance. As the temperature increases, the resistance increases.

The trade number also identifies the size, shape, number of filaments, and amount of light produced. The amount of light produced is measured in **candlepower.** For example, the candlepower of a #1156 bulb, commonly used for backup lights, is 32. A #194 bulb, commonly used for dash or side marker lights, is rated at only 2 candlepower. The amount of light produced by a bulb is determined by the resistance of the filament wire, which also affects the amount of current (in amperes) required by the bulb. See Figures 18–2 and 18–3.

It is important that the correct trade number of bulb always be used for replacement to prevent circuit or component damage. The correct replacement bulb for your vehicle is usually listed in the owner's manual or service manual. See Figure 18–4 and the bulb chart.

Typical Automotive Light Bulbs

Trade Number	Design Volts	Design Amperes	Watts: P = I × E
37	14.0	0.09	1.3
37E	14.0	0.09	1.3
51	7.5	0.22	1.7
53	14.4	0.12	1.7
55	7.0	0.41	2.9
57	14.0	0.24	3.4
57X	14.0	0.24	3.4

(continued)

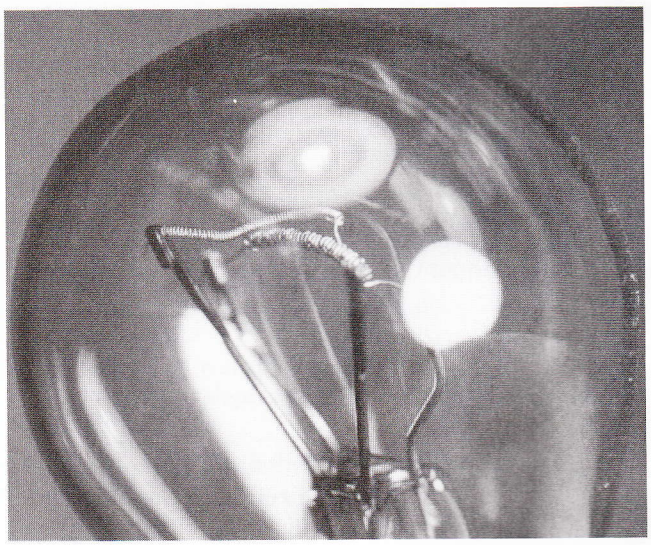


Figure 18–3 Close-up of a dual-filament (double filament) bulb (#1157) that failed. Notice that one filament (top) broke from its mounting and melted onto the lower filament. This bulb caused the dash lights to come on whenever the brakes were applied.

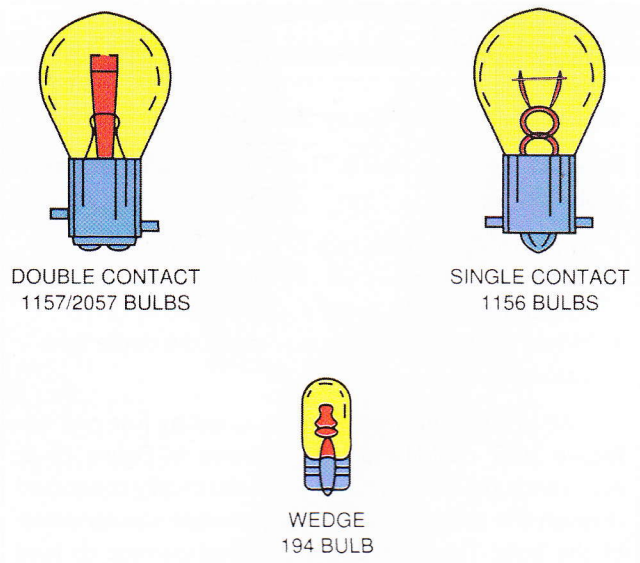


Figure 18–4 Bulbs #1157 or #2057 are typically used for taillight and front parking lights. These bulbs contain both a low-intensity filament for taillights or parking lights and a high-intensity filament for brake lights and turn signals.

Trade Number	Design Volts	Design Amperes	Watts: P = I × E
63	7.0	0.63	4.4
67	13.5	0.59	8.0
68	13.5	0.59	8.0
70	14.0	0.15	2.1
73	14.0	0.08	1.1
74	14.0	0.10	1.4
81	6.5	1.02	6.6
88	13.0	0.58	7.5
89	13.0	0.58	7.5
90	13.0	0.58	7.5
93	12.8	1.04	13.3
94	12.8	1.04	13.3
158	14.0	0.24	3.4
161	14.0	0.19	2.7
168	14.0	0.35	4.9
192	13.0	0.33	4.3
194	14.0	0.27	3.8
194E-1	14.0	0.27	3.8
194NA	14.0	0.27	3.8
209	6.5	1.78	11.6
211-2	12.8	0.97	12.4
212-2	13.5	0.74	10.0
214-2	13.5	0.52	7.0
561	12.8	0.97	12.4
562	13.5	0.74	10.0
563	13.5	0.52	7.0
631	14.0	0.63	8.8
880	12.8	2.10	27.0
881	12.8	2.10	27.0
906	13.0	0.69	9.0
912	12.8	1.00	12.8
1003	12.8	0.94	12.0
1004	12.8	0.94	12.0
1034	12.8	1.80/0.59	23.0/7.6
1073	12.8	1.80	23.0
1076	12.8	1.80	23.0
1129	6.4	2.63	16.8
1133	6.2	3.91	24.2
1141	12.8	1.44	18.4
1142	12.8	1.44	18.4
1154	6.4	2.63/0.75	16.8/4.5
1156	12.8	2.10	26.9
1157	12.8	2.10/0.59	26.9/7.6
1157A	12.8	2.10/0.59	26.9/7.6
1157NA	12.8	2.10/0.59	26.9/7.6
1176	12.8	1.34/0.59	17.2/7.6
1195	12.5	3.00	37.5
1196	12.5	3.00	37.5
1445	14.4	0.13	1.9
1816	13.0	0.33	4.3
1889	14.0	0.27	3.8
1891	14.0	0.24	3.4
1892	14.4	0.12	1.7
1893	14.0	0.33	4.6
1895	14.0	0.27	3.8
2033	13.5	0.22	3.0
2057	12.8	2.10/0.48	26.9/6.1
2057NA	12.8	2.10/0.48	26.9/6.1
2322-1	12.0	0.16	2.0
2721	12.0	0.10	1.2
2821	12.0	4.00	3.0
2825	12.0	0.42	5.0
3057	12.8	0.16	2.1
3157	12.0	1.10	12.8

(continued)

Trade Number	Design Volts	Design Amperes	Watts: P = I × E
3796	12.0	6.00	2.0
3893	12.0	3.00	4.0
3894	12.0	4.00	3.0
3898	12.0	6.00	2.0
3966	12.0	4.00	3.0
5004	12.0	4.00	3.0
5006	6.0	1.20	5.0
5007	12.0	2.40	5.0
5008	12.0	1.20	10.0
6418	12.0	0.42	5.0
6428	12.0	0.25	3.0
6461	12.0	0.83	10.0
7230	12.0	2.40	5.0
7301	12.0	3.75	45.0
7309	12.0	2.92	35.0
7506	12.0	0.60	21.0
7527	12.0	0.69	18.0
7528	12.0	2.40	5.0
7533	12.0	0.80	15.0
9004 H*	12.8	5.00/35.00	65.0/45.0
9005 H+	12.8	5.00	65.0
9006 H^	12.8	4.30	55.0
26736	12.0	0.83	10.0
64150 H1	12.0	4.50	55.0
64151 H3	12.0	4.50	55.0
64152 H1	12.0	8.30	100.0
64153 H3	12.0	8.30	100.0
64173 H2	12.0	4.50	55.0
64174 H2	12.0	8.30	100.0
64185 H4	12.0	2.90	35.0
64193 H4	12.0	5.00	60.0
P25-1	13.5	1.86	25.1
P25-2	13.5	1.86	25.1
R19/5	13.5	0.37	5.1
R19/10	13.5	0.74	10.0
W10/3	13.5	0.25	3.4

DIAGNOSTIC STORY

Weird Problem—Easy Solution

A General Motors minivan had the following electrical problems:

- The turn signals flash rapidly on the left side.
- With the ignition key off, the lights-on warning chime sounds if the brake pedal is depressed.
- When the brake pedal is depressed, the dome light comes on.

All of these problems were caused by just one defective 2057 dual-filament bulb shown in Figure 18–5. Apparently, the two filaments were electrically connected through the corrosion observed between the terminals of the bulb. This caused the electrical current to feed back from the brake light filament into the taillight circuit causing all the problems. See Figure 18–6 for another example of a weird bulb problem.

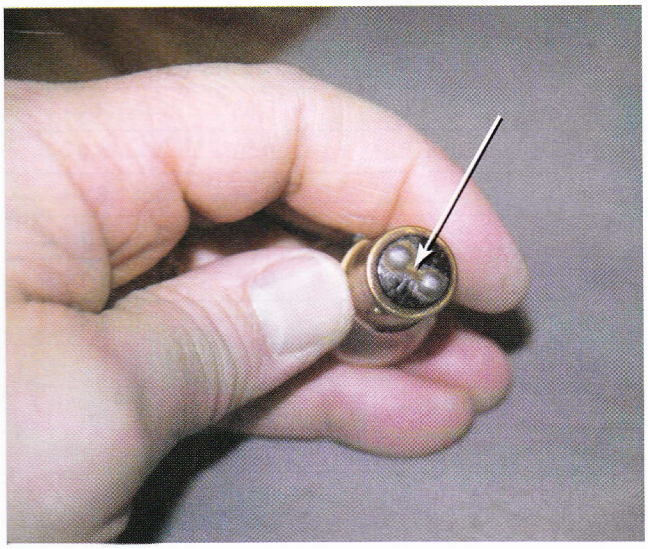


Figure 18–5 Corrosion caused the two terminals of this dual-filament bulb to be electrically connected.

BRAKE LIGHTS

Brake lights use the high-intensity filament of a double-filament bulb. (The lower intensity filament is for the taillights.) The brake light switch is a normally open (N.O.) switch but is closed when the driver depresses the brake pedal. Since 1986, all vehicles sold in the United States have a third brake light commonly referred to as the **center high-mounted stop light (CHMSL).** The brake switch

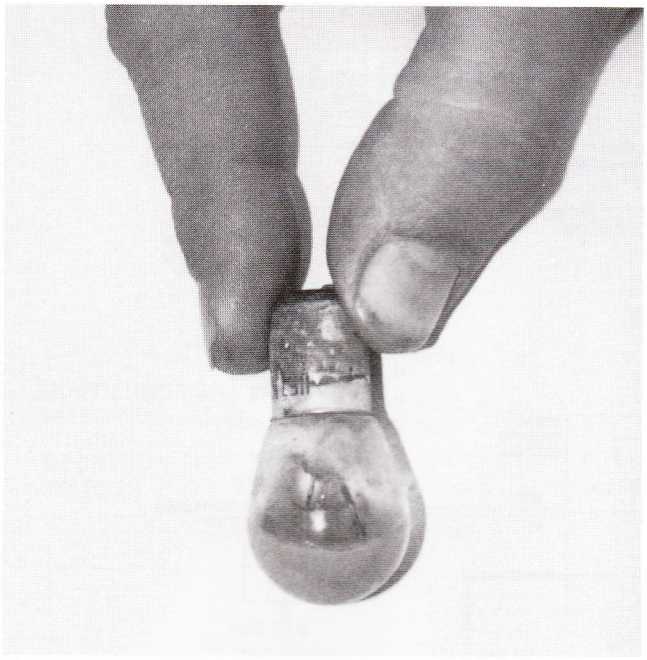


Figure 18–6 Often the best diagnosis is a thorough visual inspection. This bulb was found to be filled with water, causing weird problems.

TECH TIP

No Cruise Control? Check the Third Brake Light

A common cause of an inoperative cruise control, especially on General Motors vehicles, is a burned out bulb in the third stop light. The cruise control uses the filaments of the third brake bulb as a ground and shuts off the cruise if the bulbs are burned out (open). See Figure 18–7.

is also used as an input switch (signal) for the following:

1. Cruise control (deactivates when the brake pedal is depressed)
2. Antilock brakes (ABS)
3. Brake shift interlock (prevents shifting from "park" position unless the brake pedal is depressed)

HEADLIGHT SWITCHES

The headlight switch operates the exterior and interior lights of most vehicles. The headlight switch is connected directly to the battery through a fusible link and has continuous power or is "hot" all the time. A circuit breaker is built into most headlight switches to protect the headlight circuit. See Figure 18–8. The interior dash lights can be dimmed manually by rotating the headlight switch knob, which controls a variable resistor (called a **rheostat**) built into the headlight switch.

The rheostat drops the voltage sent to the dash lights. Whenever there is a voltage drop (increased resistance), there is heat. A coiled resistance wire is

TECH TIP

Heavy-Duty Automotive Bulbs

Many automotive bulbs have the same operating parameters (same wattage, voltage, amperage, and candlepower) yet have different trade numbers. Some numbers are for standard duty, whereas others have heavier filament wire or additional filament support, which qualifies them for a different trade number. A fleet-duty designation represents some increase in durability, and a heavy-duty designation identifies the most severe service bulb.

Regular	Fleet Duty	Heavy Duty
53	182	1445 or 53X
57	293	1895
67	97	97
68	96	96
69	98	631
90	99	—
93	1093	—
158	193	194
161	184	—
1003	105	—
1004	104	—
1034	198	1157
1034A	—	1157NA/1157A
1073	199	1156
1141	1159	—
1889/1891	1893	1893
4000	—	4040
6014	—	6015

Therefore, if the specification for your vehicle gives a trade number listed under the "regular" heading, you can safely switch to the trade number of bulb listed under the "fleet-duty" or "heavy duty" heading. For best operation of turn signals and consistent brightness of bulbs, the switch of trade numbers should include all similar bulbs of the type being replaced.

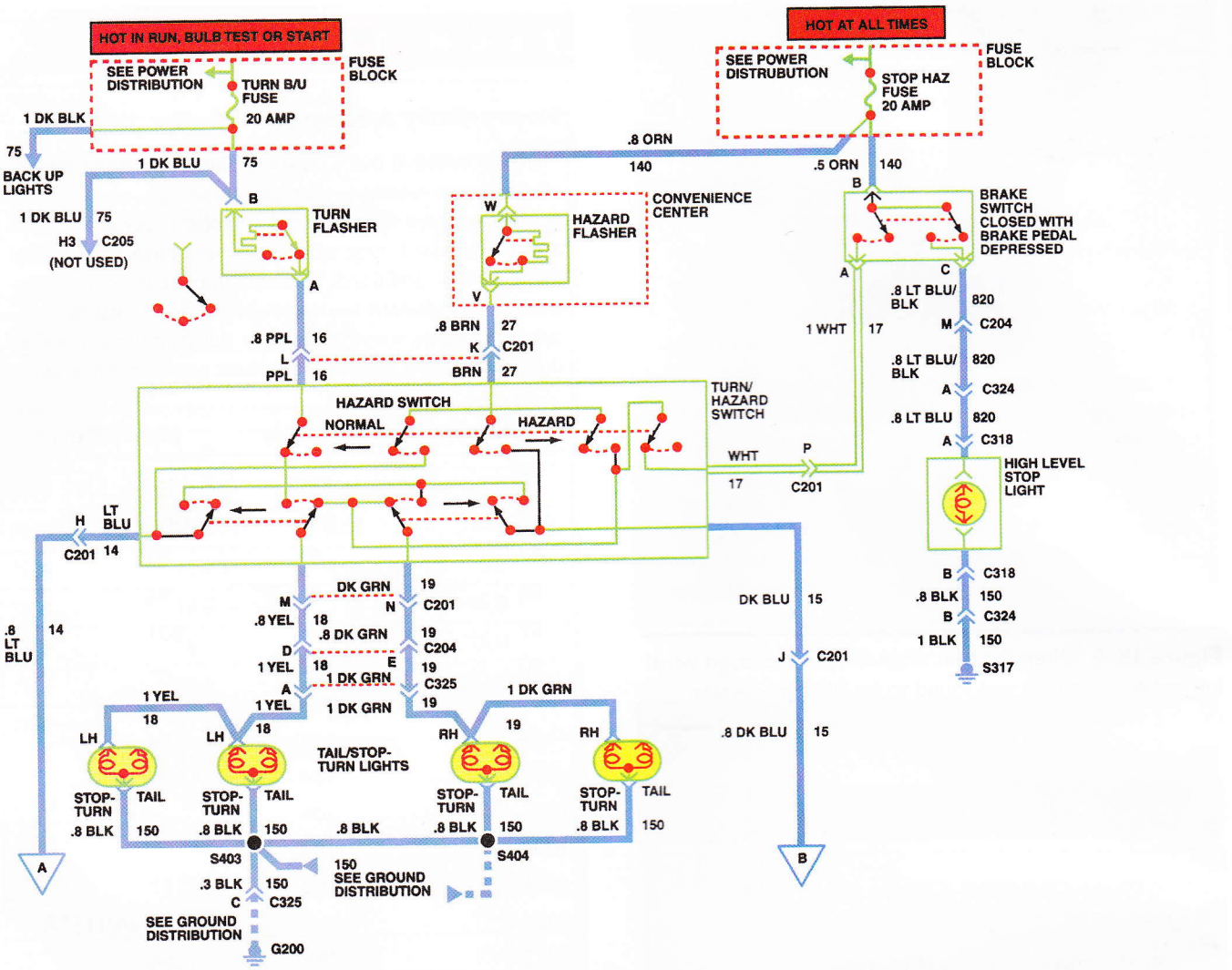


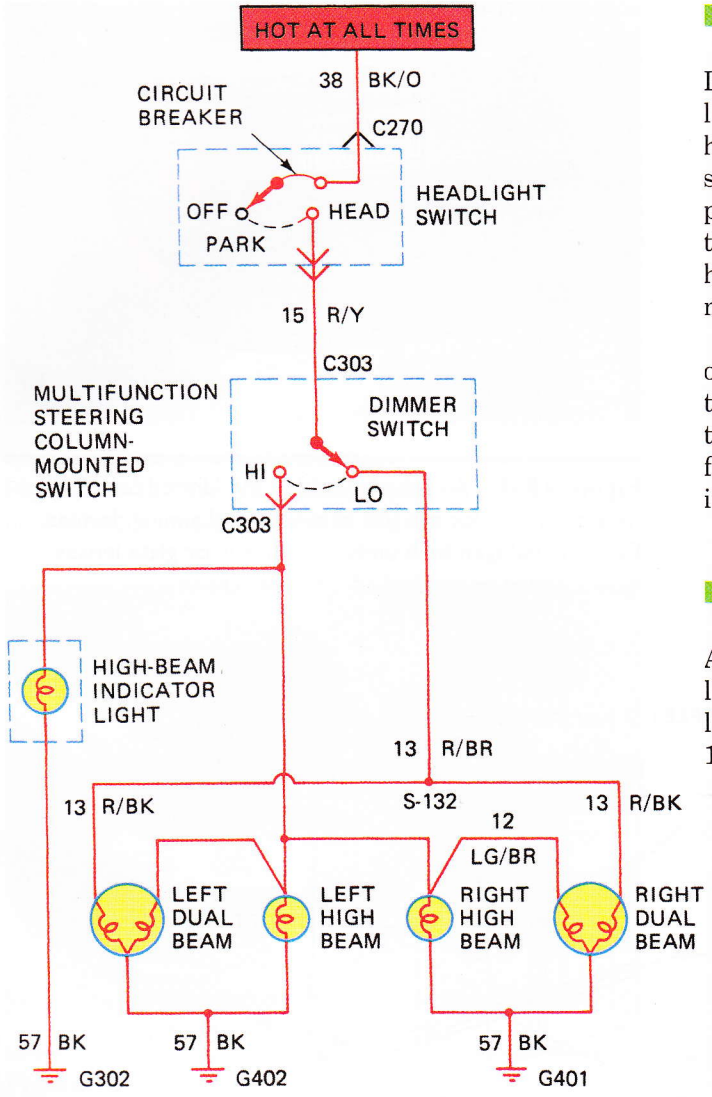
Figure 18–7 Typical brake light and taillight circuit showing the brake switch and all of the related circuit components.

built into a ceramic holder that is designed to insulate the rest of the switch from the heat and allow heat to escape. Continual driving with the dash lights dimmed can result in the headlight switch knob getting hot to the touch. This is normal, and the best prevention is to increase the brightness of the dash lights to reduce the amount of heat generated in the switch. The headlight switch also contains a built-in circuit breaker that will rapidly turn the headlights on and off in the event of a short circuit. This prevents a total loss of headlights. If the headlights are rapidly flashing on and off, check the entire headlight circuit for possible shorts. The circuit breaker controls only the headlights. The other lights controlled by the headlight switch (taillights, dash lights, and parking lights) are fused separately. Flashing headlights may also be caused by a failure in the built-in circuit breaker, requiring replacement of the switch assembly.

Removing a Headlight Switch

Most dash-mounted headlight switches can be removed by first removing the dash panel. However, to get the dash panel off, the headlight switch knob usually has to be removed. Some knobs can be removed by depressing a small clip in a notch in the knob itself. Other headlight switch knobs are removed by depressing a spring-loaded release, which allows for removal of the entire headlight switch knob and shaft as shown in Figure 18–9.

Headlight switches mounted on the steering column are removed as part of the turn signal and wiper switch assembly. Many can be easily removed, whereas others require the removal of the steering wheel and so forth. See the service information for the exact year and model on which you are working in order to be assured of the correct procedure.



SEALED-BEAM HEADLIGHTS

Low-beam headlights contain two filaments: one for low beam and the other for high beam. High-beam headlights contain only one filament. Headlights are standardized so that sealed-beam units that can be purchased at most auto parts stores can replace them. Because low-beam headlights also contain a high-beam filament, the entire headlight assembly must be replaced if either filament is defective.

A sealed-beam headlight can be tested with an ohmmeter. A good bulb should indicate low ohms between the ground terminal and both power-side (hot) terminals. If either the high-beam or the low-beam filament is burned out, the ohmmeter will indicate infinity (OL). See Figure 18–10.

HEADLIGHT AIMING

According to U.S. federal law, all headlights, regardless of shape, must be able to be aimed using headlight aiming equipment. See Figures 18–11 through 18–13.

Figure 18–8 Typical headlight circuit diagram. Note that the headlight switch is represented by a dotted outline indicating that other circuits (such as dash lights) also operate from the switch.

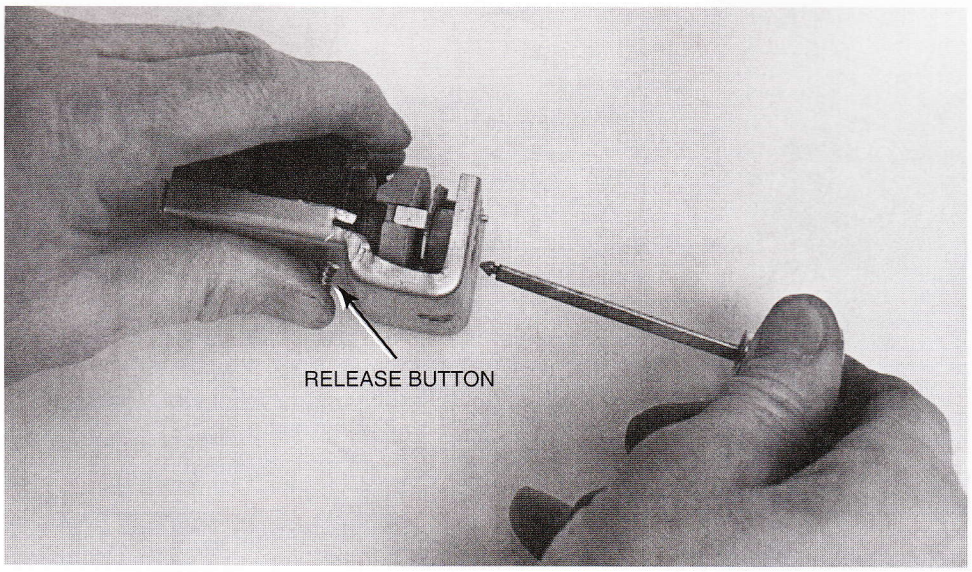


Figure 18–9 To remove the headlight switch from a vehicle that uses a knob and shaft, a release button has to be pushed to release the shaft. After the knob and shaft assembly has been removed, then the retaining nut can be removed from the headlight switch so it can be removed from the dash.

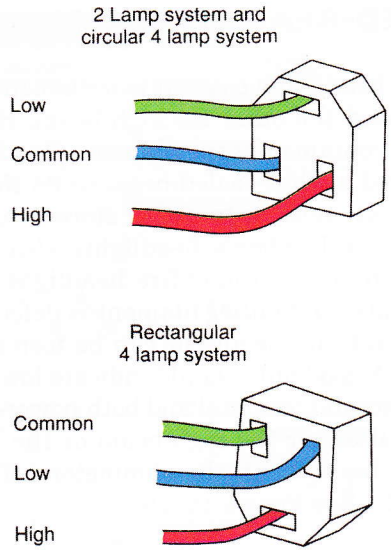


Figure 18–10 Typical headlight socket connections. Some vehicles may be different. The high- and low-beam connections must be determined by visual inspection.

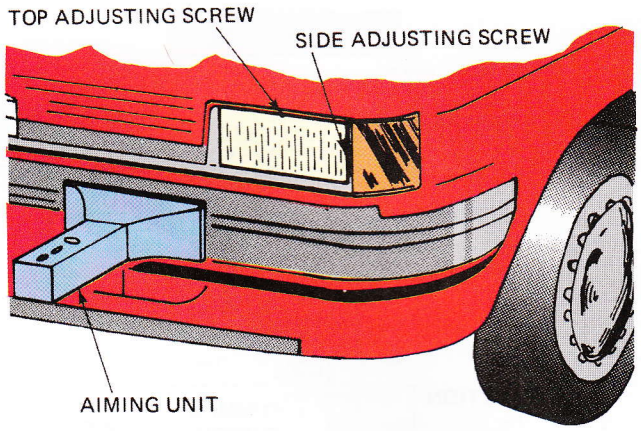
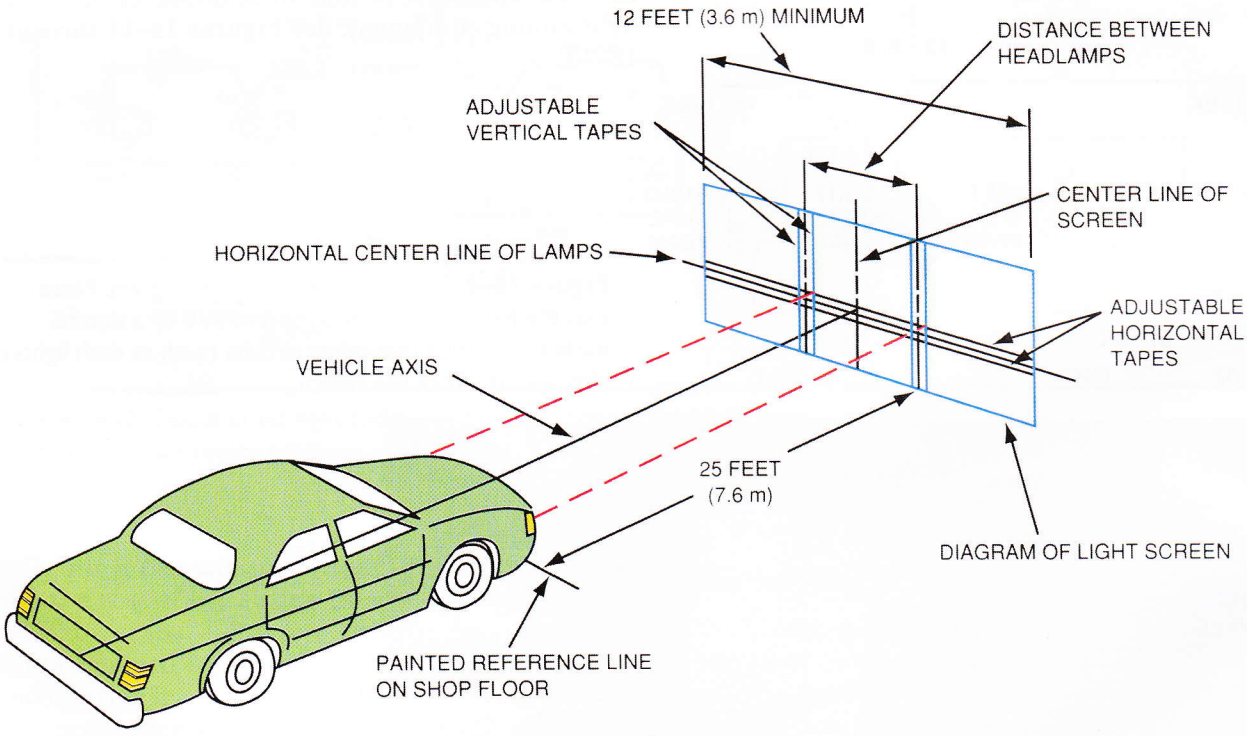


Figure 18–11 All vehicles sold in the United States must have provision for the use of mechanical aiming devices. Even the halogen bulb units with plastic or glass lenses have locating points and adjustment screws.



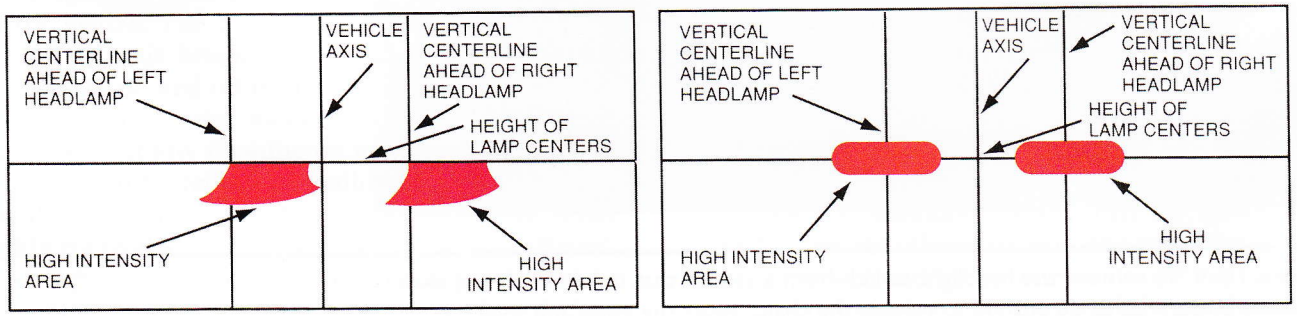


Figure 18–12 Typical headlight-aiming diagram as found in a service manual.

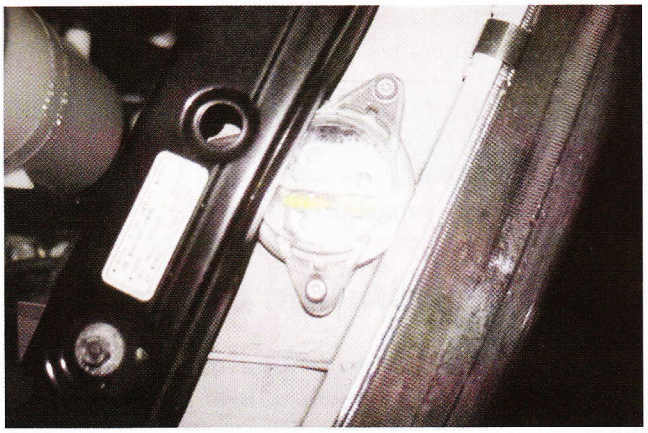


Figure 18–13 Many composite headlights have a built-in bubble level to make aiming easy and accurate.

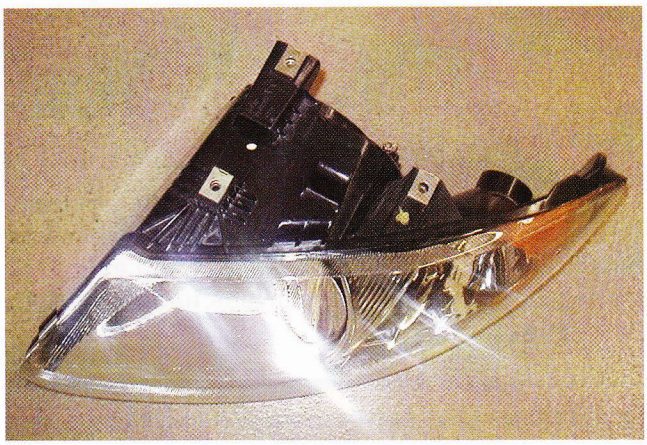


Figure 18–14 A typical composite headlamp assembly. The lens, housing, and bulb sockets are usually included as a complete assembly.

COMPOSITE HEADLIGHTS

Composite headlights are constructed using a replaceable bulb and a fixed lens cover that is part of the vehicle. See Figure 18–14. The replaceable bulbs are usually bright halogen bulbs. Halogen bulbs get very hot during operation (between 500° and 1300° F [260° and 700° C]). It is important never to touch the glass of any halogen bulb with bare fingers because the natural oils of the skin on the glass bulb can cause the bulb to break when it heats during normal operation.

HALOGEN SEALED-BEAM HEADLIGHTS

Halogen sealed-beam headlights are brighter and more expensive than normal headlights. Because of their extra brightness, it is common practice to have

TECH TIP ✔

Diagnose Bulb Failure

Halogen bulbs can fail for various reasons. Some causes for halogen bulb failure and their indications are as follows:

- Gray color—low voltage to bulb (check for corroded socket or connector)
- White (cloudy) color—indication of an air leak
- Broken filament—usually caused by excessive vibration (see Figure 18–15)
- Blistered glass—indication that someone has touched the glass

NOTE: *Never touch the glass ampoule of any halogen bulb.* The oils from your fingers can cause unequal heating of the glass during operation, leading to a shorter-than-normal service life.

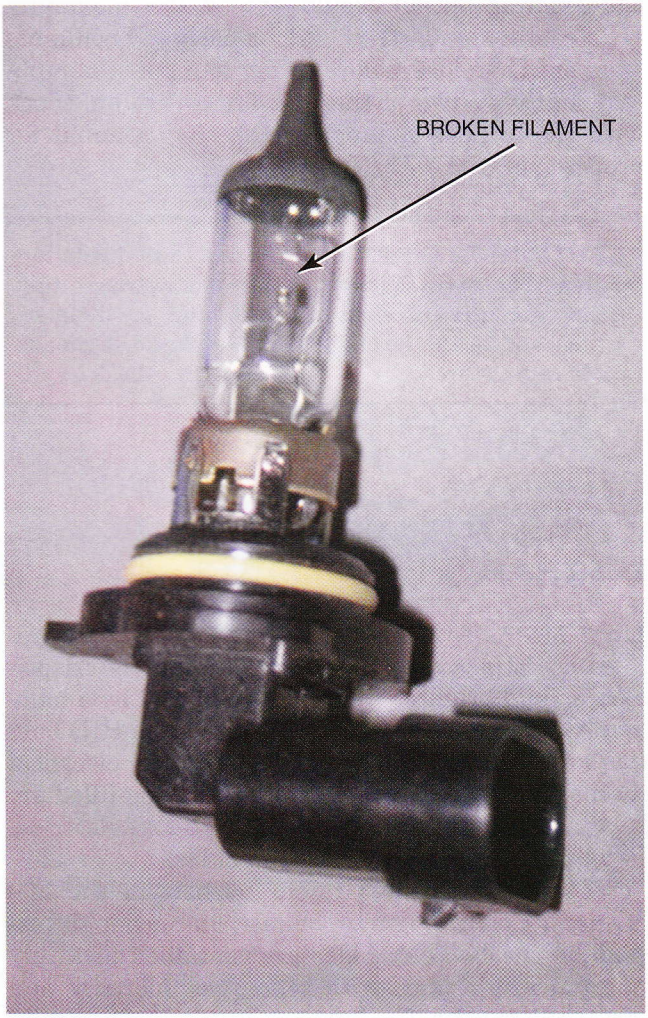


Figure 18–15 Notice the broken filament in this halogen headlight bulb.

Figure 18–16 HID (Xenon) headlights emit a whiter light than halogen headlights and usually look blue.

only two headlights on at any one time because the candlepower output would exceed the maximum U.S. federal standards if all four halogen headlights were on. Therefore, before trying to repair the problem that only two of the four lamps are on, check with the owner's manual or the shop manual for proper operation.

CAUTION: Do not attempt to wire all headlights together. The extra current flow could overheat the wiring from the headlight switch through the dimmer switch and to the headlights. The overloaded circuit could cause a fire.

HIGH-INTENSITY DISCHARGE HEADLIGHTS

High-intensity discharge (HID) headlights produce a distinctive blue-white light that is crisper, clearer, and brighter than light produced by a halogen headlight. Unlike a halogen bulb, the HID bulb has no filament. It creates light from an electrical discharge between two electrodes in a gas-filled arc tube. It produces twice the light with less electrical input than conventional halogen bulbs.

The HID lighting system consists of the discharge arc source, igniter, ballast, and headlight assembly. The two electrodes are contained in a tiny quartz capsule filled with xenon gas, mercury, and metal halide salts. The lights and support electronics are expensive, but they should last the life of the vehicle unless physically damaged. See Figure 18–16.

The temperature of daylight compared to various types of bulbs includes:

- Daylight—5400° K
- HID—4100° K
- Halogen—3200° K
- Incandescent (tungsten)—2800° K

DAYTIME RUNNING LIGHTS

Daytime running lights (DRLs) involve operating front parking lights or the headlights (usually at reduced current and voltage) whenever the vehicle is running. Canada has required daytime running lights on all new vehicles since 1990. DRLs have reduced accidents where used.

Daytime running lights primarily use a control module that turns on either the low- or high-beam lamps. The lights on some vehicles come on whenever the engine starts. Some vehicles will turn on the lamps when the engine is running, but delay their operation until a signal from the vehicle speed sensor indicates that the vehicle is moving.

To avoid having the lights on during servicing, some systems will turn off the headlights whenever the parking brake is applied. Others will only light the headlights when the vehicle is in a drive gear. See Figure 18–17.

CAUTION: Most factory daytime running lights operate the headlights at reduced intensity. These are *not* designed to be used at night. Normal intensity of the headlights (and operation of the other external lamps) is actuated by turning on the headlights as usual.

DIMMER SWITCHES

The headlight switch controls the power or hot side of the headlight circuit. The current is then sent to the dimmer switch, which allows current to flow to either the high-beam or the low-beam filament of the headlight bulb as shown in Figure 18–18. An indicator light lights on the dash whenever the bright lights are selected.

The dimmer switch can be either foot operated on the floor or hand operated on the steering column. The popular steering column switches are actually attached to the *outside* of the steering column on most vehicles and are spring loaded. To replace most of these types of dimmer switches, the steering column needs to be lowered slightly to gain access to the switch itself, which is also adjustable for proper lever operation.

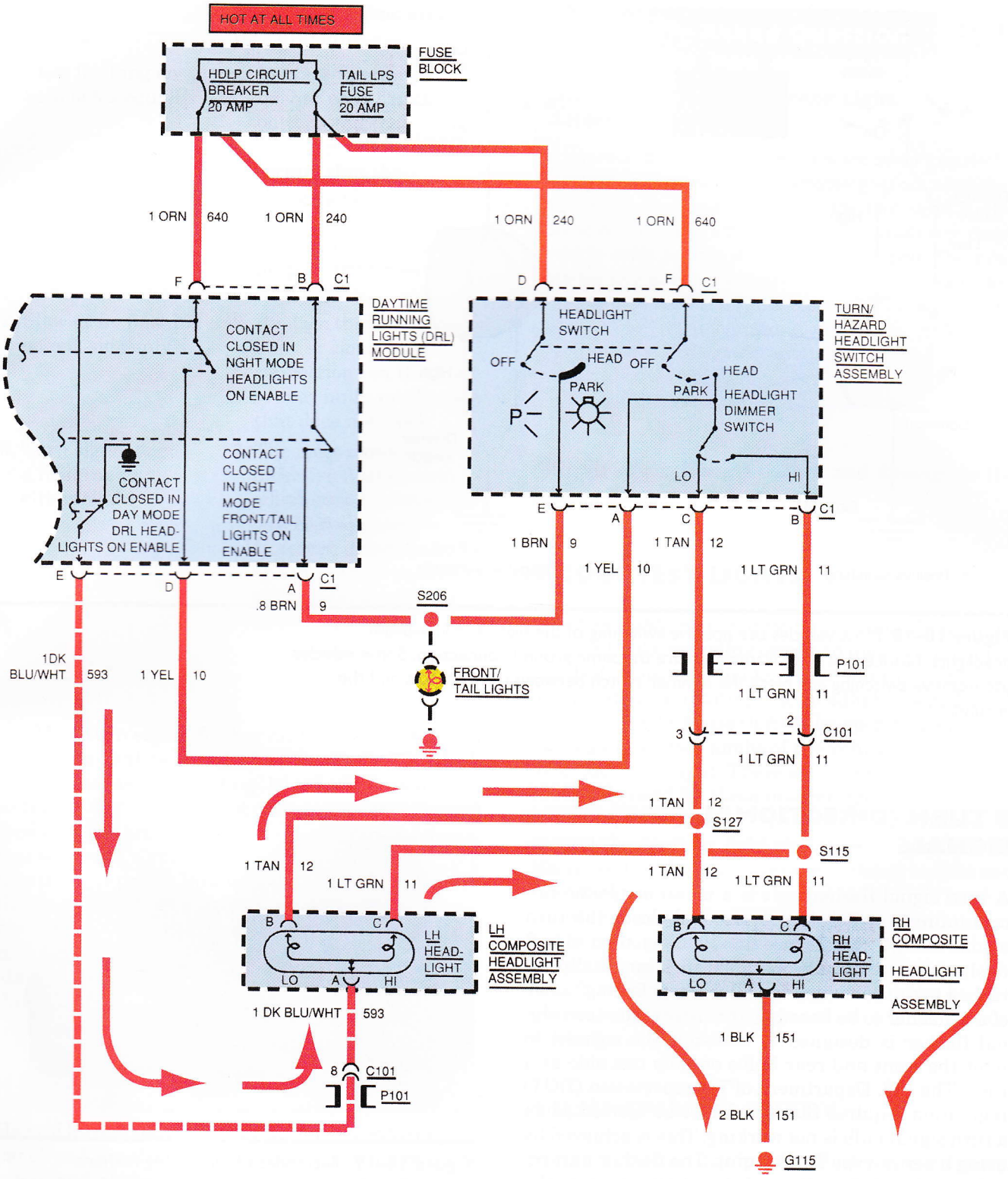


Figure 18–17 Typical daytime running light (DRL) circuit. Follow the arrows from the DRL module through both headlights. Notice that the left and right headlights are connected in series, resulting in increased resistance, less current flow, and dimmer than normal lighting. When the normal headlights are turned on, both headlights receive full battery voltage, with the left headlight grounding through the DRL module.

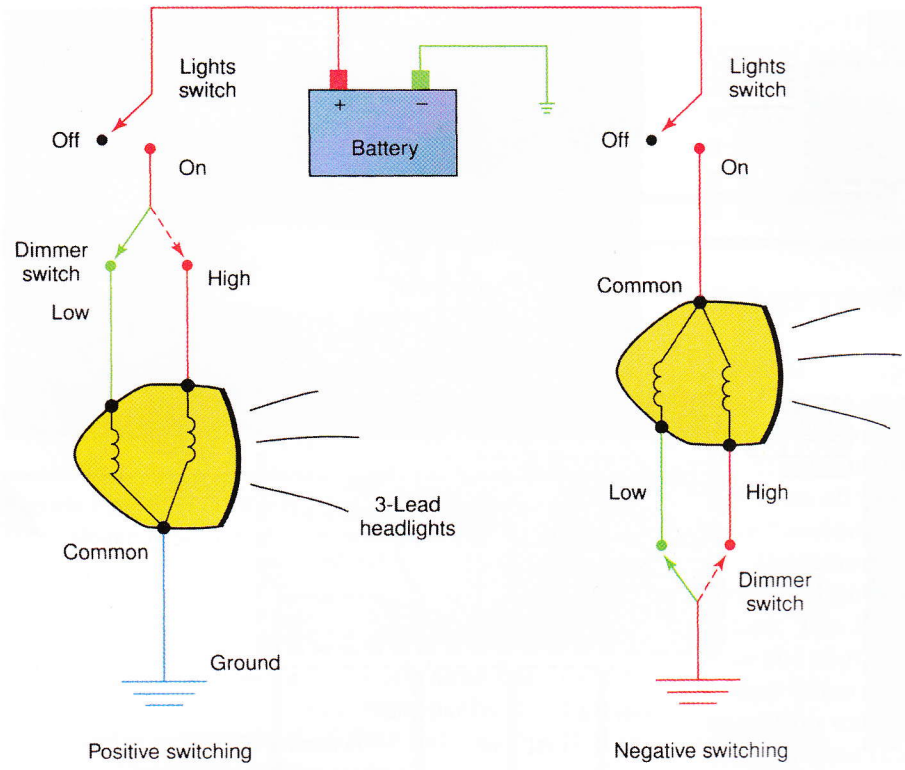


Figure 18–18 Most vehicles use positive switching of the high- and low-beam headlights. Notice that both filaments share the same ground connection. Some vehicles use negative switching and place the dimmer switch between the filaments and the ground.

TURN (DIRECTIONAL) SIGNALS

A turn signal flasher unit is a metal or plastic can containing a switch that opens and closes the turn signal circuit. See Figure 18–19. This turn signal flasher unit is usually installed in a metal clip attached to the dash panel to allow the "clicking" noise of the flasher to be heard by the driver. The turn signal flasher is designed to transmit the current to light the front and rear bulbs on only one side at a time. The U.S. Department of Transportation (DOT) regulation requires that the driver be alerted when a turn signal bulb is not working. This is achieved by using a series-type flasher unit. The flasher unit requires current flow through two bulbs (one in the front and one in the rear) in order to flash. If one bulb burns out, the current flow through only one bulb is not sufficient to make the unit flash; it will be a steady light. These turn signal units are often called DOT flashers. When the turn signal flasher unit is old, the lights will flash more slowly (both sides affected equally). The contact points inside the flasher unit may become corroded and pitted, requiring higher voltage to operate. To restore normal operation, replace the turn signal flasher unit. Other common turn signal problems and possible solutions include the following:

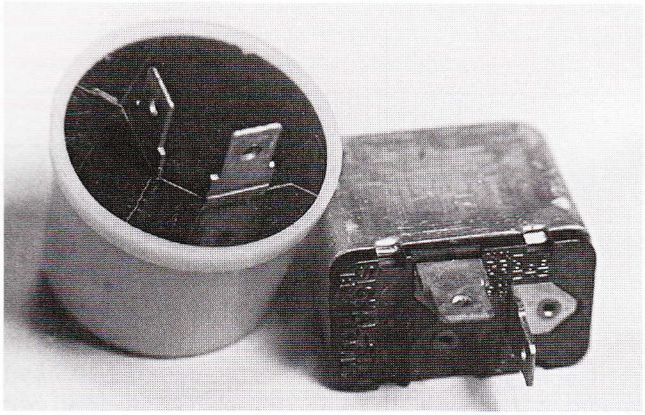


Figure 18–19 Two styles of two-prong flashers.

Problem	Possible Causes and/or Solutions
1. Slow flashing on both sides equally	1. Replace the worn flasher unit. Check the battery and the charging voltage to be certain that the charging circuit and battery are supplying high-enough voltage for proper operation of the turn signals.
2. Slow or no flashing on one side only	2. Replace the defective bulb, or clean poor connections on the front or rear bulbs on the side that does not work.
3. Turn signals not a flashing on either side	3. The most likely cause is defective flasher unit, in which case replacement will be necessary. However, defective bulbs or connections on *both* sides could also be the cause.

Most turn signal flasher units are mounted in a metal clip that is attached to the dash. The dash panel acts as a sounding board, increasing the sound of the flasher unit. Most four-way hazard flasher units are plugged into the fuse panel. Some two-way turn signal flasher units are also plugged into the fuse panel. How do you know for sure where the flasher unit is located? With both the turn signal and the ignition on, listen and/or feel for the clicking of the flasher unit. Some service manuals also give general locations for the placement of flasher units.

HAZARD FLASHERS

Hazard flasher units are usually plugged into the fuse panel and are designed to flash four or more bulbs safely and at the same flashing speed regardless of the number of bulbs used in the lighting circuit.

Therefore, if trailer lights are connected to the taillights, the flasher unit for the four-way hazard flasher should be used in place of the standard turn signal flasher. However, the regular (DOT) turn signal flasher *cannot* be used for the four-way hazard flashers. The result would be the very rapid flashing of the hazard flasher and damage to the flasher itself.

Frequently Asked Question ???

Why Does the Side Marker Light Alternately Flash?

A question that service technicians are asked frequently is why the side marker light alternately goes out when the turn signal is on and is on when the turn signal is off. Some vehicle owners think that there is a fault with their vehicle while actually it is normal operation. The side marker light goes out whenever the lights are on and the turn signal is flashing because there are 12 volts on both sides of the bulb (see points X and Y in Figure 18–20). Normally, the side marker light gets its ground through the turn signal bulb.

COURTESY LIGHTS

Courtesy lights is a generic term primarily used for interior lights, including overhead (dome) and under-the-dash (courtesy) lights. These interior lights can be operated by rotating the headlight switch knob fully counterclockwise (left) or by operating switches located in the door jambs of the vehicle doors and/or near the dome light. There are two types of circuits commonly used for these interior lights. Most manufacturers, except Ford, use the door switches to ground the courtesy light circuit. See Figure 18–21. Many Ford vehicles use the door switches to open and close the power side of the circuit.

Many newer vehicles operate the interior lights through the vehicle computer or through an electronic module. Because the exact wiring and operation of these units differ, consult the service literature for the exact model on which you are working.

ILLUMINATED ENTRY

Some vehicles are equipped with illuminated entry, whereby the interior lights are turned on for a given amount of time whenever the outside door handle is operated while the doors are locked. Most vehicles equipped with illuminated entry also light the exterior door keyhole. Some vehicles equipped with body computers use the door handle electrical switch of the illuminated entry circuit to "wake up" the power supply for the body computer.

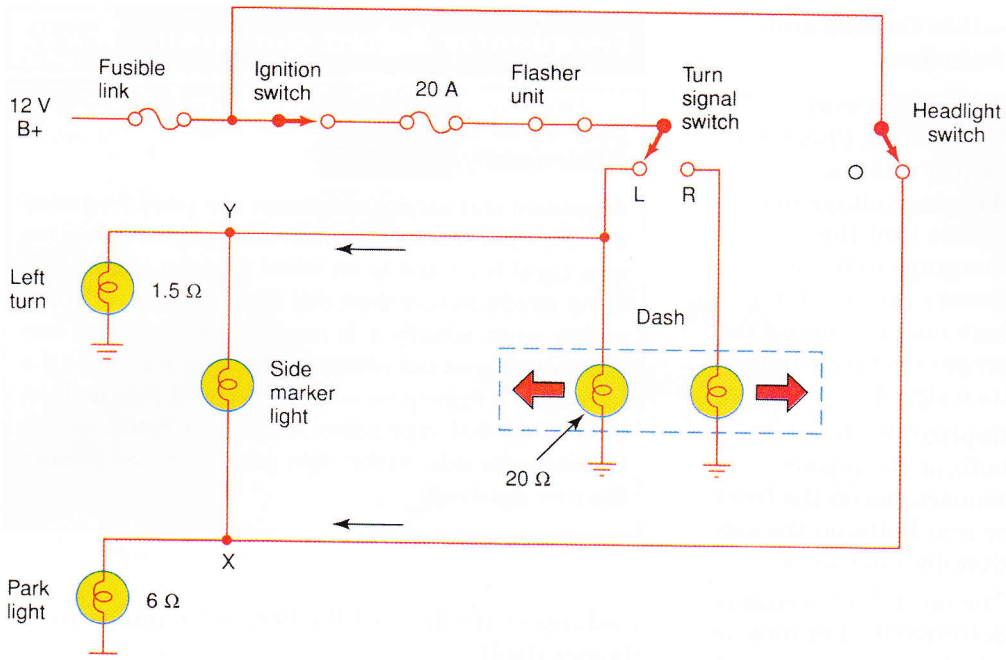


Figure 18–20 The side marker light goes out whenever there is voltage at both point X and Y. These opposing voltages stop current flow through the side marker light. The left turn light and left park light are actually the same bulb (usually a #2057) and are shown separately to help explain how the side marker light works on many vehicles.

Figure 18–21 A typical courtesy light door jamb switch. Newer vehicles use the door switch as an input to the vehicle computer and the computer turns on or off the interior lights. By placing the lights under the control of the computer, the vehicle engineers have the opportunity to delay the lights after the door is closed and to shut them off after a period of time to avoid draining the battery.

TECH TIP ✔

Service Manual Diagnosis

It used to be that if a technician could see the schematic of the circuit being diagnosed, then the problem could be corrected. From the schematic or wiring diagram, the technician could see where voltage should be at various parts of the circuit. Not any more! Many of today's vehicles use a computer to control almost everything, including interior lights. The old switches in the door jamb simply signal the computer that a door has been opened. The computer controls the lighting to help control against accidental battery drain. For example, in the event that the vehicle door has been left open, the computer can open the circuit and prevent a dead battery.

The schematic rarely shows exactly how the circuit works. However, most service manuals walk you through the diagnosis. With a service manual, or service disk if on compact disk with read-only memory (CD-ROM), the technician is not lost. Always follow the procedures exactly! Even if the service procedure sounds long and involved, the procedure will lead you to the correct diagnosis.

FIBER OPTICS

Fiber optics is the transmission of light through special plastic (polymethyl methacrylate) that keeps the light rays parallel even if the plastic is tied in a knot. These strands of plastic are commonly used in automotive applications as indicators for the driver that certain lights are functioning. For example, some vehicles are equipped with fender-mounted units that light whenever the lights or turn signals are operating. Plastic fiber-optic strands, which often look like standard electrical wire, transmit the light at the bulb to the indicator on top of the fender so that the driver can determine if a certain light is operating. Fiber-optic strands can also be run like wires to indicate the operation of all lights on the dash or console. Fiber-optic strands are also commonly used to light ashtrays, outside door locks, and other areas where a small amount of light is required. The source of the light can be any normally operating light bulb. A special bulb clip is usually used to retain the fiber-optic plastic tube near the bulb.

FEEDBACK

When current that lacks a good ground goes backward along the power side of the circuit in search of a return path (ground) to the battery, this reverse flow is called **feedback** or **reverse-bias** current flow. Feedback can cause other lights or gauges to work that should not be working.

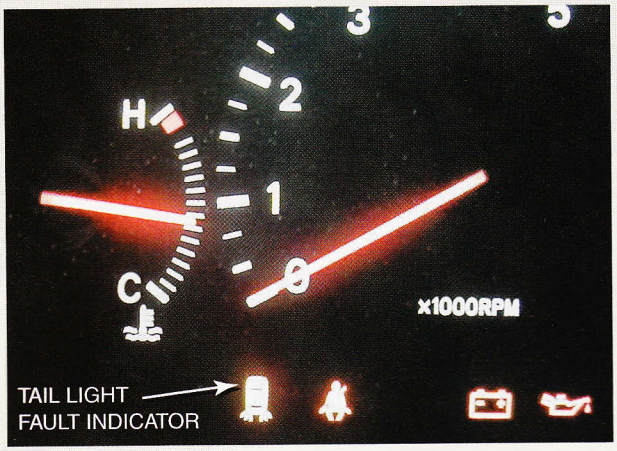
Feedback Example

A customer complained that when the headlights were on, the left turn signal indicator light on the dash remained on. The cause was found to be a poor ground connection for the left front parking light socket. The front parking light bulb is a dual filament: one filament for the parking light (dim) and one filament for the turn signal operation (bright). A corroded socket did not provide a good enough ground to conduct all current required to light the dim filament of the bulb.

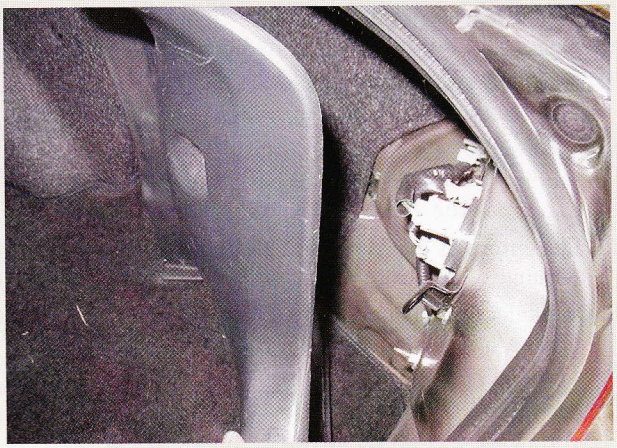
The two filaments of the bulb share the same ground connection and are electrically connected. When all the current could not flow through the bulb's ground in the socket, it caused a feedback or reversed its flow through the other filament, looking for ground. The turn signal filament is electrically connected to the dash indicator light; therefore, the reversed current on its path toward ground could light the turn signal indicator light. Cleaning or replacing the socket usually solves the problem if the ground wire for the socket is making a secure chassis ground connection.

LIGHTING SYSTEM TROUBLESHOOTING GUIDE	
Problem	**Possible Causes and/or Solutions**
One headlight	• Poor ground dim connection on body
One headlight out (dim or bright)	• Burned-out headlight filament. Check the headlight with an ohmmeter. There should be a low-ohm reading between the power-side connection and the ground terminal of the bulb.
Both high- and low-beam headlights out	• Burned-out bulbs. Check for voltage at the wiring connector to the headlights (possible open circuit to the headlights or open [defective] dimmer switch).
All headlights inoperative	• Burned-out filaments in all headlights. Check for proper charging system voltage • Defective dimmer switch • Defective headlight switch
Slow turn signal operation	• Defective flasher unit • High resistance in sockets or ground wire connections • Incorrect bulb numbers
Turn signals operating on one side only	• Burned-out bulb on affected side • Poor ground connection or defective socket on affected side • Incorrect bulb number on affected side.
Interior light(s) inoperative	• Burned-out bulb(s) • Open in the power-side circuit (blown fuse) • Open in door jamb switch(es)
Interior lights on all the time	• Shorted door jamb switch • Headlight switch turned fully counterclockwise
Brake lights inoperative	• Defective brake switch • Defective turn signal switch • Burned-out brake light bulbs • Open circuit or poor ground connection
Hazard warning lights inoperative	• Defective hazard flasher unit • Open in hazard circuit
Hazard warning lights blinking too rapidly	• Incorrect flasher unit • Shorted wiring to front or rear lights • Incorrect bulb numbers.

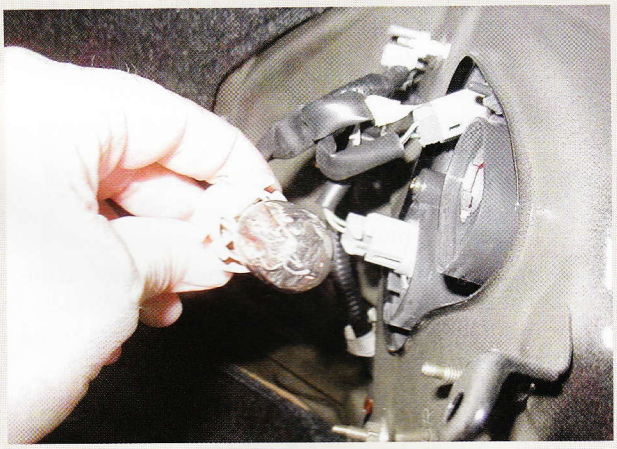
PHOTO SEQUENCE 18 Tail Light Bulb Replacement



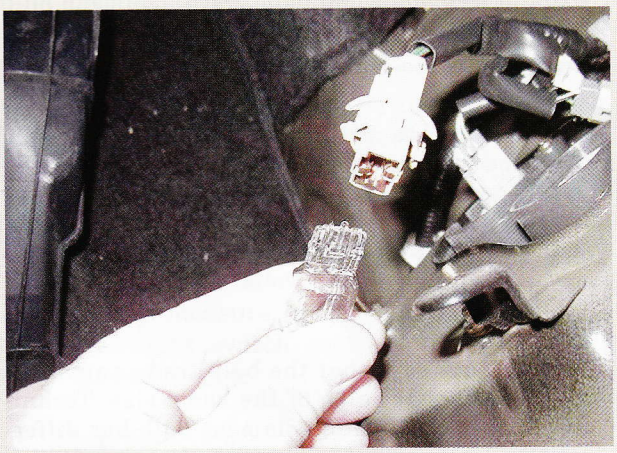
P18–1 The driver noticed that the taillight fault indicator (icon) on the dash was on any time the lights were on.



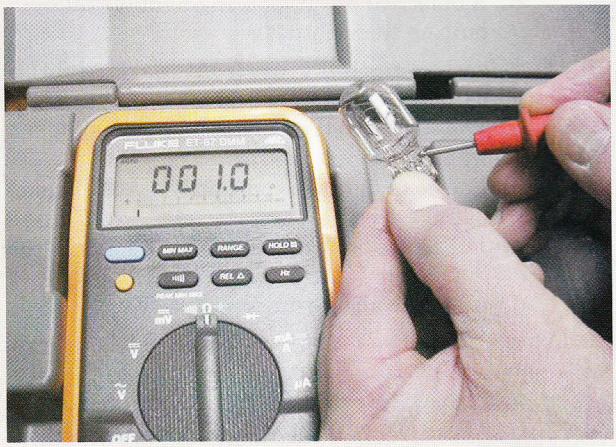
P18–2 A visual inspection at the rear of the vehicle indicated that the right rear taillight bulb did not light. Removing a few screws from the plastic cover revealed the taillight assembly.



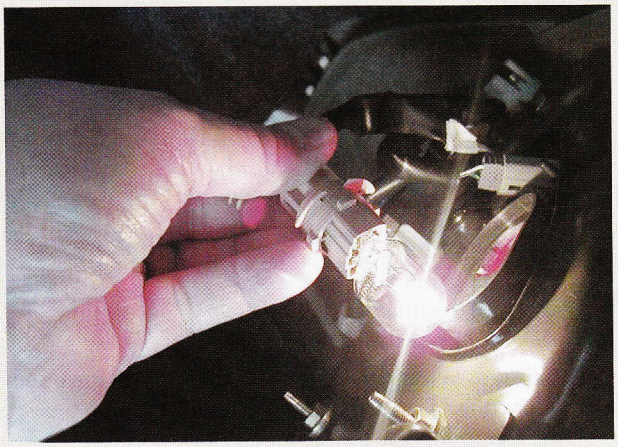
P18–3 The bulb socket is removed from the taillight assembly by gently twisting the base of the bulb counterclockwise.



P18–4 The bulb is removed from the socket by gently grasping the bulb and pulling the bulb straight out of the socket. Many bulbs require that you rotate the bulb 90° (1/4 turn) to release the retaining nibs.



P18–5 The new 7443 replacement bulb is being checked with an ohmmeter to be sure that it is OK before installing it in the vehicle.



P18–6 The replacement bulb is inserted into the taillight socket and the lights are turned on to verify proper operation before putting the components back together. The dash warning light was also off after the bulb was replaced.

SUMMARY

1. Automotive bulbs are identified by trade numbers.
2. The trade number is the same regardless of manufacturer for the exact same bulb specification.
3. Daytime running lights (DRLs) light the headlights, usually at reduced intensity, whenever the engine is running or the vehicle is moving.
4. High-intensity discharge (HID) headlights are brighter and have a blue tint.
5. One defective turn signal bulb causes the turn signal on the affected side to stop blinking (flashing).

REVIEW QUESTIONS

1. Explain why the exact same trade number of bulb should be used as a replacement.
2. Explain why you should not touch a halogen bulb with your fingers.
3. Describe how to diagnose a turn signal operating problem.
4. Discuss how to aim headlights on a vehicle equipped with aerodynamic-style headlights.

ASE CERTIFICATION-TYPE QUESTIONS

1. Technician A says that the bulb trade number is the same for all bulbs of the same size. Technician B says that a dual-filament bulb has different candlepower ratings for each filament. Which technician is correct?
   - **a.** Technician A only
   - **b.** Technician B only
   - **c.** Both Technicians A and B
   - **d.** Neither Technician A nor B
2. Two technicians are discussing flasher units. Technician A says that a DOT-approved flasher unit should be used only for turn signals. Technician B says that a variable-load flasher will function for turn signal usage, although it will not warn the driver if a bulb burns out. Which technician is correct?
   - **a.** Technician A only
   - **b.** Technician B only
   - **c.** Both Technicians A and B
   - **d.** Neither Technician A nor B
3. Interior overhead lights (dome lights) are operated by door jamb switches that _____.
   - **a.** Complete the power side of the circuit
   - **b.** Complete the ground side of the circuit
   - **c.** Move the bulb(s) into contact with the power and ground
   - **d.** Either a or b, depending on application
4. Electrical feedback is usually a result of _____.
   - **a.** Too high a voltage in a circuit
   - **b.** Too much current (in amperes) in a circuit
   - **c.** Lack of a proper ground
   - **d.** Both a and b
5. Which bulb is brightest (see the bulb table)?
   - **a.** #194
   - **b.** #168
   - **c.** #194NA
   - **d.** #57
6. If a #1157 bulb were to be installed in a left front parking brake socket instead of a #2057 bulb, what would be the most likely result?
   - **a.** The left turn signal would flash faster.
   - **b.** The left turn signal would flash slower.
   - **c.** The left parking light would be slightly brighter.
   - **d.** The left parking light would be slightly dimmer.
7. A technician replaced a #1157NA with a #1157A bulb. Which is the most likely result?
   - **a.** The bulb is brighter because the #1157A candlepower is higher.
   - **b.** The amber color of the bulb is a different shade.
   - **c.** The bulb is dimmer because the #1157A candlepower is lower.
   - **d.** Both b and c.
8. A customer complained that every time he turned on his vehicle's lights, the left-side turn signal indicator light on the dash remained on. The most likely cause is _____.
   - **a.** A poor ground to the parking light (or taillight) bulb on the *left* side
   - **b.** A poor ground to the parking light (or taillight) bulb on the *right* side causing current to flow to the left-side lights
   - **c.** A defective (open) parking light (or taillight) bulb on the left side
   - **d.** A defective (open) parking light (or taillight) bulb on the right side
9. A defective taillight or front park light bulb could cause:
   - **a.** The turn signal indicator on the dash to light when the lights are turned on
   - **b.** The dash lights to come on when the brake lights are on
   - **c.** The lights-on warning chime to sound if the brake pedal is depressed
   - **d.** All of the above
10. A defective brake switch could prevent proper operation of the _____.
    - **a.** Cruise control
    - **b.** ABS brakes
    - **c.** Shift interlock
    - **d.** All of the above